CEMVP-ED-H (1110-2-1403) 30 August 2001
Pomerleau/rp/5640

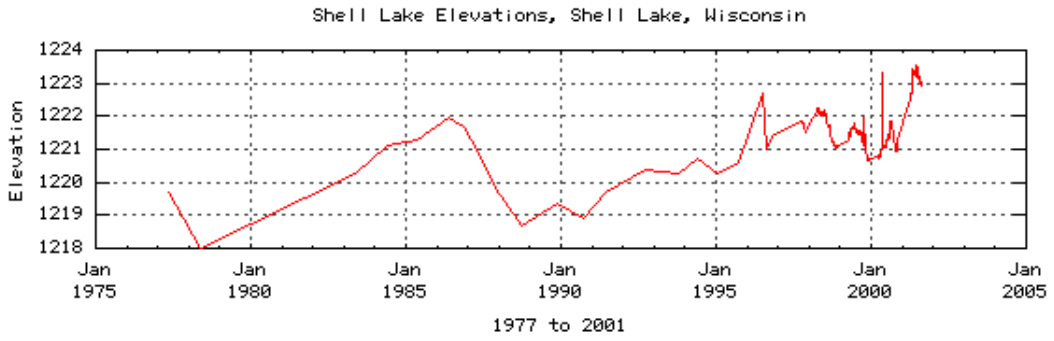
MEMORANDUM FOR RECORD

SUBJECT: Recommendations for Ice Damaage Mitigation during the Winter of 2001-2002 at Shell Lake, Wisconsin.

BACKGROUND

1. At the request of the City of Shell Lake, Wisconsin, a field trip to inspect the effect of high lake levels on Shell Lake at Shell Lake, Wisconsin was made on August 24-25, 2001. Shell lake is experiencing record high lake levels and property owners and the city want to know what, if anything, can be done to reduce potential damage from ice action during the coming winter season.

2. The historic high water elevation on Shell Lake is 1228.55 which occurred in approximately 1900. Since that time, low elevations near 1216 have been observed. On the day of the field visit, the lake was at an elevation of 1222.92. A plot of historic lake levels from 1977 to present, based on data provided by the City of Shell Lake, is shown in the following graphical plot.



3. The city has a project in the final design phases to draw the lake down by means of a gravity outlet to the Yellow River. This project, still in the approval processes, has a design discharge 20 cubic-feet-per-second (CFS). With a surface area of about 2,580 acres, this would draw the lake level down about one foot in 60 to 65 days, not counting for evaporation.

4. Some lake information cane be found in *"The Story of Shell Lake"* by Albert Stouffer (1961), published by the Washburn County Historical Society. This publication refers to courthouse records in which *"The average freeze-up occurs between November 25 and December 1. The average ice-out date occurs between April 15th and May 1"* In 1998, the ice on Shell Lake went out on April 5th.

POTENTIAL ICE PROBLEMS

5. There are two major topics concerning ice damage at Shell Lake. The first is the late fall-early winter freeze-up period in which the water

saturated soils and standing water will be subjected to freezing and subsequent expansion. The second topic is damages caused by ice shoving and run-up in the spring when the lake ice melts and winds push floes onto shore.

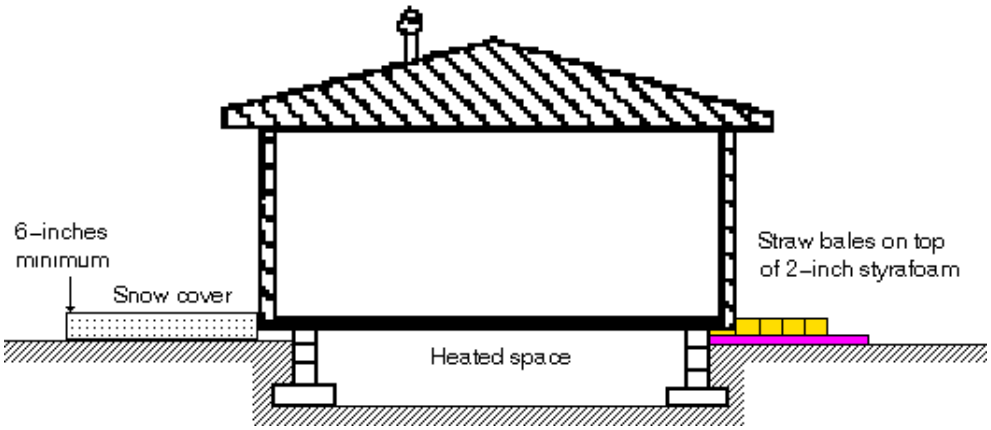
6. With the above average lake levels, it is anticipated that water will be standing in places that are otherwise dry. These areas would be susceptible to damages due to ice expansion during initial freeze-up. Ice has an expansion coefficient fives times that of steel, and ice in the 8 to 12 inch range can be aggressively active. Any structures in such areas could expect to be damaged during the late fall to early winter season. It would be prudent to move such structures such as boat lifts and docks if at all possible.

FROST HEAVE

7. Most of the houses around Shell Lake are built slab-on-grade or have footings and crawl spaces. With the high lake levels raising the ground water table in the predominantly sand area, soils in the affected area will be subjected to frost heave. Frost heave can exert strong forces on footings, slabs, and other structural elements causing cracking and displacement. Areas damaged by frost heave are then prone to water infiltration and subsequent flooding once the ground begins to thaw in the spring.

8. For an area to be susceptible to frost heave, one must have three things: below freezing temperatures, a souce of water, and frost susceptible soils. Areas where fine material such as silt is mixed in with sand will be subjected to frost heave. Areas with large amounts of clean sand, will fare better. For the problem at hand, it would be best to assume the soils are susceptible to frost heaving.

9. To only way to minimize frost heave in such situations is to keep crawl spaces and basements heated. A space heater or furnance set to keep the temperature betweeen 40 and 50 degrees fahrenheit is one method. In areas above the water line, insulating around the outside of the house with 2-nch foam sheets, dry straw, and snow will do much to retain heat in the structure and reduce soil freezing potential. Six inches of undisturbed snow will also provide insulation. Pumping water out of crawl spaces and away from residences as long as practical into the late fall will help reduce the amount of water available for freezing. Material placement are shown in the following diagram:



ICE RUNUP AND SHOVING

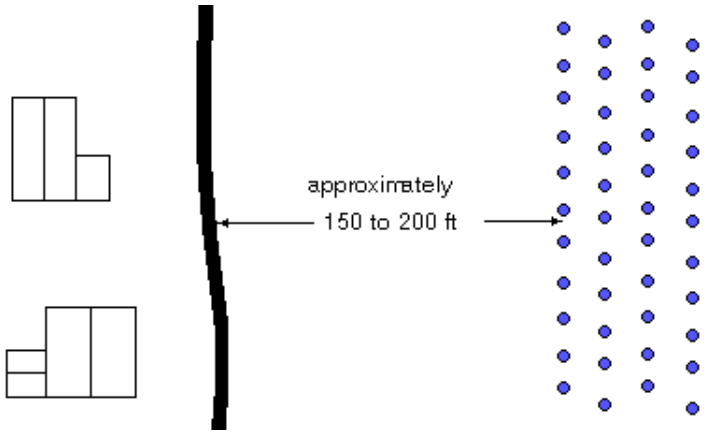
10. Ice run-up and shoving has occurred on Shell Lake. One speaker at a August 25, 2001 public meeting stated that the east side of the lake experiences ice shoving every spring. Damage occurs to the shoreline and turf is rolled and pushed up. On the northwest corner of Shell Lake, at the Gary Burkhart residence and neighbors, ice piled up 3 to 4 feet high about 100 feet back from the shoreline that existed at that time (source: personsal conversation). The lake was about one-half foot lower last spring than at present.

11. To protect against damage to property and shoreline due to possible ice thermal expansion in case of a rapid increase in temperature (and also help against rising water level and ice uplift), it is advisable to cut a trench in the ice sheet offshore from the area to be protected using a ditch witch or similar trencher. The cut should extend only 75 to 80% of the ice thickness to avoid refreezing.

12. Trenching should be done two to three weeks before the expected onset of warmer whether also to avoid refreezing. This cut will provide a line of weakness in the ice where it will break more easilty and minimize damage to the structure closer to shore. If a trencher is not available, then a line of holes may be substituted, drilled with a 4 or 6" auger. A thin layer of dark material, sand, coal dust, or ashes, can also be spread to increase solar energy absorption and melting/weakening of the ice. Again, this should be done late enough in winter when the likelyhood of a snow fall is low, but early enough for the sun to do its part.

13. The City of Oconto, Wisconsin has been using a tractor-mounted ice auger to drill holes in the ice since 1991. The US Army Cold Regions and Research Laboratory (CRREL) has a bulletin on this on the internet. The URL is http://www.crrel.usace.army.mil/ierd/tectran/rbh/ieib14.htm. A PDF version of the report is also available. At Oconto, 9-inch auger holes are drilled 8 to 10 feet apart in a staggered fashion.

14. Although Oconto is located on a river, rather than a lake, the same technology of drilling holes to mechanically weaken the ice apply to Shell Lake. Trenching or drilling should be completed 3 to 4 weeks before the expected ice-out date. The following sketch shows a layout pattern that could be used for trenching or augering.



15. Ice can also be weakened by dusting the ice cover with leaf mulch.

As with augering or trenching, dusting is done about one month before the expected ice-out date, and hopefully after the end of any seasonal snowfalls. If the city has a fall leaf collection program, a readily available source of dusting material could be pressed into service. Given the limitted amount of time available in the spring, dusting with leaves would be the least desireable of the ice weakening measures discussed.

RECOMMENDATIONS

16. In order to mitigate ice damage at Shell Lake, the following measures are recommended.

a) Continue pumping water away from structures as long as practical.

b) Maintain some form of heat between 40 and 50 degrees in buildings.

c) Insulate homes with foam and/or straw as shown above.

d) Identify risk-prone areas for ice run-up and shoving. Formulate and execute a plan to weaken the ice cover by trenching or augering. Contacting the City of Oconto, Wisconsin to solicit input would expedite plan formulation.

e) Devils Lake, North Dakota has been experiencing high lake levels in recent years also. The City may wish to contact the Devils Lake City Engineers' office at 701-662-7615 or the Ramsey County Emergency Manager, Tim Heisler, at 701-662-7001 to see if they have any experiences which may help Shell Lake.

17. It is also recommended that areas of concern be monitored during the winter and early spring season. Photographs and/or video imagery taken in these areas before, during, and after freeze-up could provide value documentation.

/signed/

RICHARD POMERLEAU, P.E.
Senior Hydraulic Engineer